Original Article

High Return to Play Rate and Reduced Career Longevity Following Surgical Management of Athletic Pubalgia in National Basketball Association Players

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Purpose: To assess the effects of surgical treatment of athletic pubalgia (AP) on game use and performance metrics in National Basketball Association (NBA) players. **Methods:** A retrospective review of all NBA players who underwent surgical management for AP from 1996 to 2018 was performed. A matched control group was created for comparison. The index period was defined as the entire NBA season in which surgery occurred, including the corresponding offseason. Player demographics, use (games played, games started, and minutes per game) and performance (player efficiency rating) metrics were collected for all players. Statistical analysis was performed to compare data before and after return to play. **Results:** Thirty players with a history of surgical management for AP were included in the final analysis. Following surgery for AP, NBA players were found to have a return to play (RTP) rate of 90.91% (30/33). The average RTP following surgery was 4.73 ± 2.62 months. Compared with control athletes, athletes in the AP group played significantly fewer seasons postinjury (4.17 ± 2.70 vs 5.49 ± 3.04 seasons, respectively; $P = .02$). During the first year following RTP, NBA players experienced significant reductions in game use and performance, both when compared with the year prior and matched control athletes ($P < .05$). At 3-year follow-up, players continued to demonstrate significant reductions in game use (minutes per game, $P < .05$) but not performance. **Conclusions:** Following surgical treatment of AP, NBA players demonstrated a high RTP rate, but shortened career. A short-term reduction in game use and performance metrics was found the year of return following surgery. However, 3-year follow-up performance metrics normalized when compared with healthy controls. **Study Design:** Level III; retrospective case-control study.

Lower-extremity injuries have been shown to comprise more than 60% of all injuries in National Basketball Association (NBA) players.[1-3] Athletic pubalgia (AP), or sports hernia, has become increasingly recognized in athletes over time, often presenting as chronic groin or lower abdominal pain without evidence of a true hernia.[4-6] Basketball players are particularly at high risk of AP due to the physical demand of the sport requiring rapid cutting, sprinting, sudden acceleration, and deceleration.[6-8] These physical activities may create imbalanced strain and tension on the muscles and tendons surrounding the pubis and may lead to injury.[9,10] In a retrospective review of 8490 patients over 2 decades, basketball players were among the top 5 sports affected by AP, comprising 6.2% of patients.[6]

AP encompasses a broad spectrum of pathologies and includes injury to the posterior inguinal wall, rectus

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abdominis insertion, adductor tendons, inguinal nerves, or pubic symphysis.[8,11] Initial treatment often consists of rest, anti-inflammatories, and physical rehabilitation.[9,12] For those who do not respond to conservative therapy, surgery is indicated. The wide variety of pathology has led to a diversity of surgical options,[6] many of which have been shown to have superior outcomes over conservative management.[9,13,14] Compared with recreational athletes, however, professional athletes endure greater physical demands and may elect to have surgery to return-to-play (RTP) sooner at an elite level. In NBA players, the impact of surgical intervention following RTP is yet to be determined.

While some professional athletes have been shown to successfully RTP at a high level of performance after AP surgical repair, there is limited information available regarding game use and performance in NBA players following RTP.[15-17] The purpose of this study is to assess the effects of surgical treatment of AP on game use and performance metrics in NBA players. The authors hypothesized that NBA athletes requiring surgical intervention would demonstrate shortened careers but, in the long term, players would maintain game use and performance metrics.

Methods

A retrospective review of all NBA player who underwent surgical management for AP from 1996 to 2018 was performed. Publicly available injury reports (from espn.com, nba.com, nbcsports.com, etc.), news articles, player profiles, and game previews of starting lineups were used to identify all NBA players who underwent surgical management of AP, similar to previous literature.[18-21] To verify these reports, at least 2 separate online articles corroborating the injury was deemed sufficient. In addition, the date of surgery was identified, and game statistics were analyzed to confirm missing data following the surgery to confirm consistency with the news reports. For offseason surgeries, 2 articles detailing a reported surgery sufficed for inclusion. Players were excluded if the injury or surgery occurred outside of NBA participation, concomitant injuries were documented, or the player missed significant playing time for other injuries within 2 years before or after the index season, or if the player failed to RTP sufficiently following injury. Failure of RTP was defined as fewer than 15 games in the first season following RTP without substantial increase in seasons thereafter.

The index period was defined as the entire NBA season in which surgery occurred, including the corresponding preseason and offseason, such that the first season following RTP from surgery was considered season +1. In-game statistical metrics were collected for the 3 seasons prior to the index period and the 3 seasons after RTP. The seasons prior to index were labeled −1, −2, and −3; the seasons following RTP were labeled +1, +2, and +3. Player demographics (age, position, height, weight, and body mass index [BMI]), use (games played [GPS], games started [GS], and minutes per game [MPG]) and performance (Player Efficiency Rating [PER]) metrics were collected for all players. Months until return to play (RTP) was determined based on the amount of time passed between date of surgery and the first NBA regular season game indicating RTP. Only regular season NBA games were included in the statistics.

A control group was created for comparison, consisting of a 2:1 control to study group ratio, where controls group players were matched by age, position, BMI, years of experience, era of play, and index season PER. The control index season was chosen so that the age and seasons of experience of the control were similar to the matched player undergoing AP surgical repair. Matching for BMI and PER was allowed within a 5-point range of the respective study subject's BMI and PER. To mitigate differences in the era of play, the index season for the healthy controls was matched within 5 years of the study group players' index season. Years of experience before the index season was within ±2 years.[18]

Comparisons between the healthy control group and the surgically treated study group were then conducted for game use and performance statistics before and after the index season in several varieties. Changes in game use and performance were compared between the season directly before the index season and the season directly after RTP for an analysis of direct impact of injury in the short term. In addition, a 3-year comparison was made between the average game use and performance parameters over the 3-year span before the index season and the 3-year span following RTP, to provide an appropriate longer-term representation of these parameters without the acute impact of injury and rehabilitation, similar to previous studies.[18,19,22] Furthermore, relative percentages of these parameters were calculated for postindex statistics, by creating a "baseline preindex" value derived from a weighted-average of seasons −1 and −2. Relative percentages of postindex values were calculated to have a more robust sample of statistics, using methods similar to previous literature.[18,23] Relative percentages for performance (PER) and game use metrics were calculated for the first season and third season following RTP, and compared between control and study groups, to evaluate for short- and long-term changes in use and performance in relation to each individual players' preinjury baseline.[18,23,24]

Statistical Analysis

Categorical variables were reported as counts and column percentages, N (%), whereas continuous

Table 1. Demographic Characteristics of NBA Players Sustaining Sports Hernia Versus Matched Controls

	Hernia (N = 30)	Control (N = 60)	*P* Value
Age	28.57 ± 3.44	28.57 ± 3.41	1
BMI	24.70 ± 1.71	24.17 ± 1.61	.17
Yr Exp	6.60 ± 2.93	6.71 ± 2.75	.86
PER 2 Yr Preinjury	15.29 ± 5.59	15.56 ± 4.71	.81
Position			1
Point Guard	9 (30%)	18 (30%)	
Shooting Guard	7 (23%)	14 (23%)	
Small Forward	4 (13%)	8 (13%)	
Power Forward	6 (20%)	12 (20%)	
Center	4 (13%)	8 (13%)	
Month to RTS	4.73 ± 2.62		
Number seasons postinjury	4.17 ± 2.70	5.49 ± 3.04	**.02**

NOTE. Continuous variables are presented using mean ± standard deviation. Categorical variables are presented using frequency (percentage). Age is represented by years; height is represented in centimeters; weight is represented in kilograms; and Yr Exp is represented in years. Significant values are noted in bold, $P < .05$.

BMI, body mass index; NBA, National Basketball Association; PER 2 Yr Preinjury, player efficiency rating 2 years preinjury; RTS, return to sport; TOI, time of injury; Yr Exp, years of experience.

variables were reported as mean ± standard deviation. When we evaluated categorical data, univariate 2-group analysis was performed using χ^2 tests for all cell counts >5 and Fisher exact tests when cell counts were <5. Wilcoxon rank sum tests were used continuous variables with non-normal distributions, whereas independent 2 sample *t* tests were applied for normally distributed continues variables. When examining pre- and postindex data, comparison was achieved using paired *t* tests when normally distributed, with differences calculated as (post-pre). Statistical significance was set as $P < .05$. All statistical tests were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Demographics

Forty players were identified with a history of surgical management for AP from 1996 to 2018. Seven players met exclusion criteria. In addition, 3 players did not RTP with sufficient game data for analysis and were excluded. Thirty NBA athletes were included in the final analysis and matched to 60 controls. Following surgery for AP, NBA players were found to have a RTP rate of 90.91% (30/33). The 2 groups did not significantly differ in terms of demographic variables (Table 1). The average RTP following surgery was 4.73 ± 2.62 months. Compared with control athletes, athletes in the AP group played significantly fewer seasons postinjury (4.17 ± 2.70 vs 5.49 ± 3.04 seasons, respectively; $P = .02$). A total of 10 players (33%) retired before the completion of 3 postindex seasons.

Game Use and Performance

During the first year following RTP from surgery as compared with the year prior to index (Table 2), NBA players experienced significant reductions in GPS (68.60 ± 12.64 vs 61.43 ± 12.38; $P = .01$), GS (46.87 ± 26.30 vs 31.93 ± 26.89; $P = .02$), MPG (29.68 ± 5.54 vs 25.08 ± 7.23; $P < .01$), and PER (15.77 ± 4.09 vs 13.71 ± 4.55; $P < .01$). When we evaluated performance and use 3 years following RTP from surgery as compared with the 3 years prior to index, the AP cohort demonstrated significant reductions in GPS (71.20 ± 13.29 vs 59.29 ± 18.73; $P = .03$) and MPG (28.49 ± 6.95 vs 22.89 ± 8.85; $P = .04$) (Table 3).

Relative Percentage Comparison

During the first year after RTP, NBA players in the AP group demonstrated significantly reduced relative percentages of MPG (86.99% ± 18.97 vs 100.32% ± 31.38; $P = .02$) and PER (88.57% ± 20.26 vs 99.07% ± 20.82; $P = .01$) compared with control players (Fig 1). No statistically significant differences were found for GPS and GS between groups. During the third year after RTP, NBA players in the AP group only demonstrated a significantly reduced relative percentage of MPG (78.59 ± 28.07 vs 96.75 ± 33.84; $P = .04$) compared with control players (Fig 1), with relative performance no longer different between groups.

Discussion

Our study found that the majority (90.91%) of NBA players successfully RTP following surgical treatment of AP. Following RTP, players experienced decreased

Table 2. Game Use and Performance 1 Year Before and After Return to Sport

Time Point	Hernia (N = 30)	Control (N = 60)
GPS		
Pre	68.60 ± 12.64	67.31 ± 16.05
Post	61.43 ± 12.38	65.54 ± 13.22
P-value	**.01**	.52
GS		
Pre	46.87 ± 26.30	41.45 ± 29.73
Post	31.93 ± 26.89	37.96 ± 30.25
P value: time	**.02**	.53
MPG		
Pre	29.68 ± 5.54	26.84 ± 8.25
Post	25.08 ± 7.23	26.45 ± 7.79
P value: time	**<.01**	.79
PER		
Pre	15.77 ± 4.09	15.62 ± 4.09
Post	13.71 ± 4.55	15.76 ± 5.69
P value: time	**<.01**	.87

NOTE. Continuous variables are presented using adjusted mean ± standard error. *P* values with significance, $P < 0.05$, are indicated by bold text.

Time: *P* value compares pre vs post values within the same group.

GPS, games per season; GS, games started; MPG, minutes per game; PER, player efficiency rating.

Table 3. Game Use and Performance Three Years Before and After Return to Sport

Time Point	Hernia (N = 30)	Control (N = 60)
GPS		
Pre	71.20 ± 13.29	62.53 ± 19.98
Post	59.29 ± 18.73	63.45 ± 20.03
P value: time	**.03**	.81
GS		
Pre	48.68 ± 27.17	41.14 ± 29.60
Post	35.23 ± 29.12	39.55 ± 32.37
P value: time	.14	.79
MPG		
Pre	29.39 ± 6.98	26.94 ± 9.68
Post	22.99 ± 8.58	25.71 ± 8.39
P value: time	**.02**	.49
PER		
Pre	15.77 ± 4.85	15.77 ± 4.28
Post	12.84 ± 5.73	14.56 ± 5.22
P value: time	.09	.21

NOTE. Continuous variables are presented using adjusted mean ± standard error. *P* values with significance, $P < .05$, are indicated by bold text.

Time: *P* value compares pre vs post values within the same group.

GPS, games per season; GS, games started; MPG, minutes per game; PER, player efficiency rating.

game use and performance in the year of return compared with matched controls. At 3-year follow-up, game use and performance metrics normalized with the exception of MPG. In addition, players returning from surgical treatment of AP were found to have shorter careers compared with matched controls. These results suggest that NBA players RTP at a high rate after surgical treatment of AP. Game use and performance are most affected in the acute period and the injury may affect overall career length.

Previous literature has highlighted remarkably successful rates of RTP following AP ranging from 80% to 100% across multiple sports.[6,13,15,16,25-30] From 1996 to 2015, 56 National Football League (NFL) players who underwent AP surgery had a RTP rate of 94.7%.[25] A cohort of predominately amateur and professional soccer players likewise experienced a 94.4% RTP rate after laparoscopic inguinal disruption repair.[27] In the National Hockey League, 80% of hockey players are reported to successfully RTP after AP repair.[26] Similar to investigations in other professional arenas, our study demonstrates a high RTP rate of 90.91% in NBA athletes following surgical treatment of AP. This is in line with previously reported rates exceeding 90% in other professional sports. Furthermore, a variety of factors beyond the index injury may affect RTP success, such as history of previous injuries, stage in career, trades, and team dynamics.

Successful RTP is not only determined by the ability to play but by the ability to do so at a similar level to preinjury baseline and comparable with other players. There is conflicting evidence in the literature regarding game use and performance following surgical treatment of AP in professional sports.[15,17,25] Jack et al.[25] compared 56 NFL players who underwent surgical treatment of AP to a control group, finding that those in the surgery group played in significantly fewer seasons (3.8 ± 2.4 vs 3.2 ± 2.1 years) and GPS (14.0 ± 2.3 vs 12.0 ± 3.4) after RTP; however, they found no difference in performance between groups.[25] A retrospective review of NFL combine participants (mean age 22.1 years old) with a history of surgical treatment for AP was conducted by Knapik et al.,[17] who found no significant impact on GPS, GS, draft status, roster activity, or number of seasons played. Our study evaluated NBA players of slightly older age (mean 28.6 years old) and found significantly fewer seasons played following surgical treatment of AP, as well as reduced game use and performance acutely after surgery compared with controls. Interestingly, however, we found that NBA players returned to their baseline use and performance metrics at 3-year follow-up, aside from persistently decreased MPG. Whether their reduced career length or MPG following surgical treatment is attributed to their older age at time of surgery as compared with the NFL cohort requires further study. However, the present findings highlight and support that NBA players have potential to return to full game use and performance capacity in the long-term following surgical treatment of AP.

Following surgical treatment of AP, understanding the appropriate time to RTP is crucial in counseling elite athletes, setting expectations of recovery, and safely returning to full activity. Previous reports of time to RTP following surgical treatment of AP show considerable variation among multiple sports, ranging from as low as 4.23 weeks to beyond 23 weeks.[16,29-33] This significant variability may be attributed to the inherent ambiguity of the term "sports hernia" or "athletic pubalgia,"[34] which encompasses multiple sites of pathology such as the rectus abdominis, inguinal wall, adductor longus tendon, and pubis symphysis.[5,10,35] In a systematic review and meta-analysis of inguinal groin pain in athletes of various skill levels from 1980 to 2013 stratified by anatomic sites, King et al.[36] reported the lowest RTP rates for adductor tendon related pain (81%) and highest RTP rates for abdominal pain (96%). Time to RTP after surgery also varied by location, with pubic and abdominal + adductor pain requiring the longest RTP times (23.1 and 21.9 weeks, respectively) whereas abdominal alone had the shortest (7.9 weeks). Kajetanek et al.[16] similarly demonstrated variable RTP time based on site of pathology, with faster RTP in those having surgery addressing only the abdominal wall as compared with the addition of adductor tenotomies (91.1 ± 21 vs 132.5 ± 39 days, $P = .02$). In the present investigation, we found that NBA players returned to

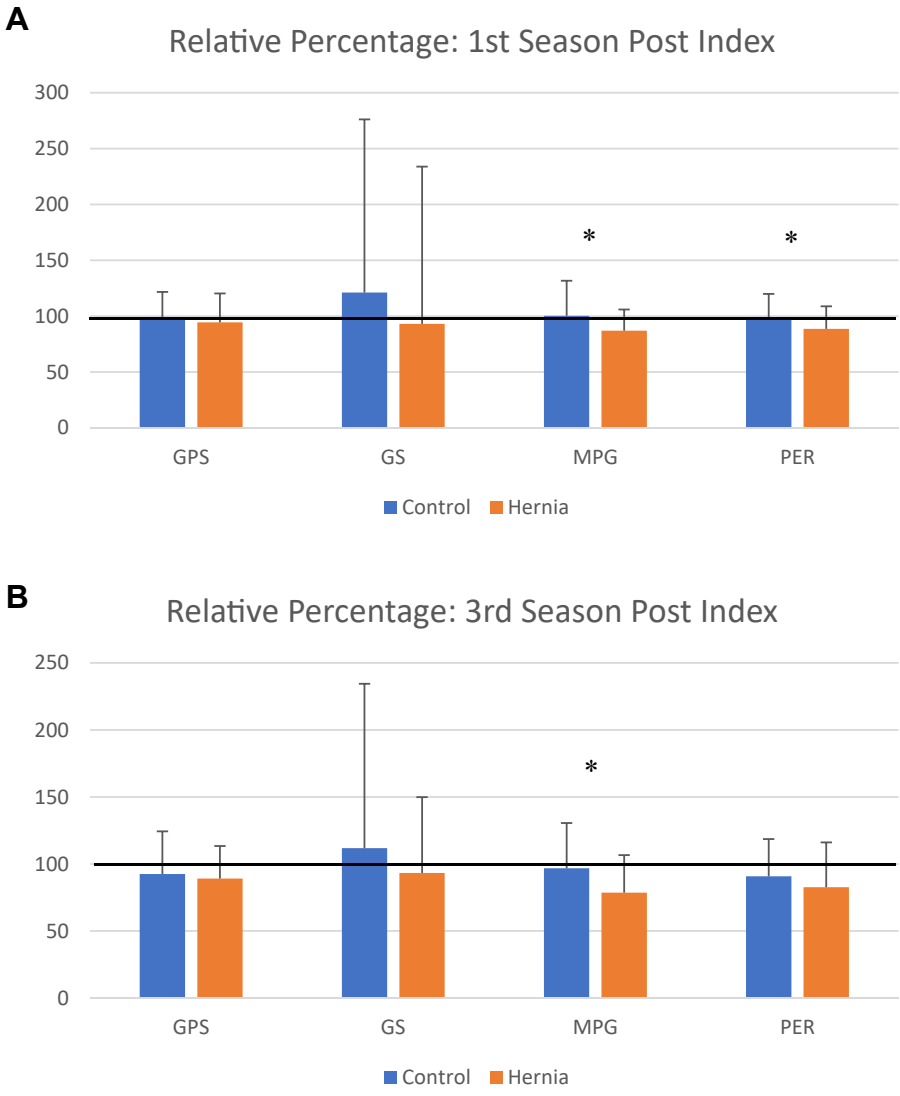

Fig 1. Relative percentage of use and performance (A) 1 season and (B) 3 seasons postindex. Preindex baseline is represented by the solid line (100%) across all variables. Relative percentages below this line indicate that the postindex variable was less than baseline. *$P < .05$ indicates significant differences between athletic pubalgia (AP) surgery and control groups. (GPS, games per season; GS, games started; MPG, minutes per game; PER, player efficiency rating.)

full competition, on average, in 4.73 ± 2.62 months, consistent with reports of other elite level athletes.[15-17] It is important to highlight that AP is a condition treated with a large variety of surgical techniques that may ultimately play a role in varying rates of RTP, time to RTP, and successful return to baseline use and performance metrics.

Limitations

Our study presents with a variety of limitations. Due to the retrospective design relying on publicly sourced data, details concerning advanced imaging, injury grading, and surgical procedure specifics were unavailable to analyze. Likewise, exact time to RTP based on timing of season and medical clearance is unable to be confirmed. Furthermore, due to the retrospective nature of the study, a power analysis was not performed, and only players with reported cases of the surgical management of AP were included. This could have led to the sample size of players influencing the statistical significance of the analysis performed. As discussed previously, AP includes a spectrum of pathologies and may require multiple types of surgeries. The lack of availability of medical records inherent to this study design prevents our ability to stratify players based on specific pathology, anatomic site, or surgical procedures. In addition, treatment and rehabilitation protocols are likely to have changed throughout the study period. Sampling bias also may occur with publicly reported data due to over-representation and reporting of injuries in more well-known or high performing players. Furthermore, despite excluding players with concomitant injuries, we are unable to definitively exclude commonly associated pathologies such as hip labral tearing and/or femoroacetabular impingement.[17,29] Future studies should correlate physical examination,

magnetic resonance imaging, and surgical findings with outcomes after AP repair in terms of workload and performance in these elite basketball players. Outside factors such as coaching, roster composition, and quality of opponents may have played a role in any changes in use and performance, as well. The process of matching controls helps to negate these differences as both the subject and control groups faced this inherent issue of playing in a professional sport similarly.

Conclusions

Following surgical treatment of AP, NBA players demonstrated a high RTP rate but shortened careers. A short-term reduction in game use and performance metrics was found the year of return following surgery. However, 3-year follow-up performance metrics normalized when compared with healthy controls.

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